NORTH CENTRAL FOREST EXPERIMENT STATION
Research Note NC-321
1992 FOLWELL AVE. ST. PAUL, MN 55108 FOREST SERVICE-U.S.D.A.
1984

# BIOMASS PRODUCTION OF 12-YEAR-OLD INTENSIVELY CULTURED *LARIX EUROLEPIS*

**Jerry Zavitkovski,** *Principal Plant Ecologist,*
*and* **Terry F. Strong,** *Forestry Technician,*
*Rhinelander, Wisconsin*

ABSTRACT.—Between 9 and 12 years *Larix eurolepis* grew annually about 1.3 m in height and 0.6 cm in diameter. In plots with 0.8 to 1.5 $m^2$ of growing space, total woody biomass increased from 70.1 to 98.8 mt/ha, and the mean annual biomass increment from 7.8 to 8.2 mt/ha.

KEY WORDS: "Scotch plaid design", spacing, growth, allometry, biomass distribution .

A previous study of *Larix eurolepis*, a hybrid between *L. decidua* and *L. leptolepis*, documented its excellent growth and biomass production under intensive culture through age 9 (Zavitkovski *et al.* 1982). At this age, the mean annual biomass increment (MABI) in plots with growing space of 0.3 $m^2$ (3 $ft^2$) and larger averaged 7.6 mt/ha (3.4 tons/acre) and the data indicated that in the next 5 to 10 years higher yields may be reached in plots with more growing space. The present study documents growth and production from 9 to 12 years of age.

## METHODS

The plantation was established in a "Scotch Plaid" design in 1972 with 2-month-old seedlings propagated in a greenhouse. A Scotch Plaid design consists of rows of trees planted at ever-increasing spacing on both the X and Y axes from a common point of origin (Zavitkovski *et al.* 1982). The planting was fertilized and irrigated and weeds were controlled with herbicides. Tree heights and d.b.h.'s were measured at irregular intervals; the last measurements were taken in the winter of 1983/84 when the planting was 12 years old. At this time two larger trees—d.b.h. 8.6 and 10.3 cm (3.4 and 4.0 in.) and heights 11.2 and 11.5 m (36.7 and 37.7 ft)—were harvested and processed as described in the previous paper (Zavitkovski *et al.* 1982). Allometric growth models, based on 8 trees harvested at age 9, and 2 trees at age 12, were developed for stem, branch, and whole tree (above ground) dry weights (table 1). Regression coefficients for stems and whole trees of the new growth model were very similar to those at age 9, suggesting that the form of the 12-year-old trees remained as it was at age 9.

## RESULTS AND DISCUSSION

From age 9 to 12, the average height of dominant trees increased from 7.5 to 11.4 m (24.5 to 37.5 ft) or by 1.3 m (4.25 ft) per year. The average d.b.h. of living trees increased from 6.5 to 8.3 cm (2.6 to 3.3 in.), or by 0.6 cm (0.25 in.) per year. In plots with growing space of 0.8 to 1.5 $m^2$ (9 to 16 $ft^2$), the survival decreased from 91 percent at age 9 to 80 percent at age 12. In plots with less than 0.23 $m^2$ (2.5 $ft^2$), survival was only 25 percent.

MABI's for growing space less than 0.7 $m^2$ (7 $ft^2$) decreased between age 9 and age 12. A slight increase in MABI was determined in larger plots (table 2). In plots with 0.8 to 1.5 $m^2$ (9 to 16 $ft^2$), woody MABI increased from 7.8 to 8.2 mt/ha (3.4 to 3.6 tons/acre) between 9 and 12 years, and is likely to further increase. In addition, the proportion of branches in the biomass decreased from 29 to 16 percent.

In comparison to heights reported in other studies with *Larix* species, the intensively cultured *L. eurolepis* grew faster. Its height at age 12 was comparable to 20-year heights reported by Chodzicki (1967) for *L. decidua*, *L. leptolepis*, and *L. eurolepis*

Table 1.—*Coefficients of allometric regression equations of 9- and 12-year-old* Larix eurolepis *(10 trees total)*

| Tree component | Regression coefficients[1] a | b | $R^2$ | $S_{y \cdot x}$ | Correction actor[2] |
|---|---|---|---|---|---|
| Whole tree[3] | -2.0089 | 2.1526 | 0.98 | 0.1264 | 1.0080 |
| Stem wood with bark | -2.5575 | 2.2964 | .99 | .1199 | 1.0072 |
| Live and dead branches | -2.6009 | 1.6733 | .82 | .3519 | 1.0618 |

[1]*For model* $Y = a + bX$ *where Y is ln (dry weight in kg) and X is ln (d.b.h. in cm).*
[2]*According to Baskerville (1972).*
[3]*Above ground without needles.*

grown in plantations in Poland. Our hybrid was taller than 14-year-old *L. eurolepis* in Denmark (Keiding 1980). It was taller than 15-year-old trees (17 years from seed) *L. decidua* in New York (Morrow 1978) and 18-year-old trees of the same species in Norway (Robak 1982). It was also taller than 16-year-old *L. leptolepis* in Scotland (Lines 1967), 14-year-old trees (16 years from seed) of the same species in Vermont (Turner and Myers 1972), and about 50 percent taller than 13-year-old trees in Japan (Hatiya *et al.* 1966). However, perhaps as a result of closer spacing, diameter growth of our hybrid lagged behind diameters reported in some of the previously mentioned studies: 15-year-old *L. decidua*'s diameters ranged from 10 to 15 cm (4 to 6 in.) (Morrow 1978) and 14-year-old *L. leptolepis* reached 15.5 cm (more than 6 in.) in Vermont (Turner and Myers 1972). The d.b.h. of a dense plantation of *L. leptolepis* averaged only 7.1 cm (2.8 in.) at age 13 (Hatiya *et al.* 1966).

We found only one study dealing with biomass of *L. eurolepis*. MABI of a 23-year-old plantation in Great Britain was 6.4 mt/ha with needles (Ovington 1956). In that study, *L. decidua* and *L. leptolepis* produced 4.1 and 3.8 mt/ha/yr, respectively. Plantations of *L. leptolepis* in Japan, produced 4.9 mt/ha/yr at age 13 (Hatiya *et al.* 1966) and 3.8 mt/ha/yr at age 21 (Satoo 1974). In Wisconsin, a 7-year-old, intensively cultured *L. laricina* produced 5.2 mt/ha/yr (Zavitkovski and Dawson 1978). A plantation of *L. sibirica* in the Volga river region produced 4.4 mt/ha/yr (Utkin *et al.* 1980). The most encouraging result of the present study is the continued high biomass production of the hybrid. At age 9, the MABI of woody parts was 7.8 mt/ha; it reached 8.2 mt/ha at age 12, and may increase still further at wider spacing.

Table 2.—*Total biomass and mean annual biomass increment of 9- and 12-year-old intensively cultured* Larix eurolepis

| Growing space ($m^2$) | Total biomass 9 | 12 | Mean annual biomass increment 9 | 12 |
|---|---|---|---|---|
| | (mt/ha) | | (mt/ha/year) | |
| 0.1-.2 | 28.3 | 33.3 | 3.1 | 2.8 |
| .2-.3 | 83.6 | 103.6 | 9.3 | 8.6 |
| .5-.6 | 56.9 | 68.9 | 6.3 | 5.7 |
| .7-.9 | 73.5 | 99.4 | 8.2 | 8.3 |
| 1.0-1.5 | 61.1 | 84.4 | 6.8 | 7.0 |
| .8-1.5 | 70.1 | 98.8 | 7.8 | 8.2 |

## LITERATURE CITED


Baskerville, G. L. Use of logarithmic regression in the estimation of plant biomass. Can. J. For. Res. 2: 49-53; 1972.

Chodzicki, Edward. Wuchs von Larchen verschiedener Herkunfte aus Europa auf der Provenienzversuchsflache in Kolanov. In: Proceedings, 14th IUFRO Congress, Section 23; Munich, W. Germany; 1967: 119-145.

Hatiya, J.; Tochiaki, K.; Fujimori, T. (Analysis of the growth of a young larch (*Larix leptolepis*) plantations with excessively high stand density.) J. Jap. For. Soc. 48(12): 445-448; 1966.

Keiding, H. Hybridlaerkens vaekst og tilpasningsevne i forhold til de rene arter. Dansk Skovforenings Tidsskrift 65: 204-234; 1980.

Lines, Roger. The international larch provenance experiment in Scotland. In: Proceedings, 14th IUFRO Congress, Section 23; Munich, W. Germany; 1967: 755-781.

Morrow, Robert R. Growth of European larch at five spacings. New York's Food and Life Sci. Bull. 75. New York: Cornell University Agricultural Experiment Station; 1978: 8-13.

Ovington, J. D. The form, weight, and productivity of tree species grown in close stands. New Phytol. 55: 289-304; 1956.

Robak, Hakon. (The international larch provenance test of 1944/45 in west Norway.) Norsk Institutt for Skogforskning 36.14; 1982.

Satoo, Taisitiroo. Primary production relations in a plantation of *Larix leptolepis* in Hokkaido: materials for the studies of growth in forest stands. Bull. Tokyo Univ. For. 66: Tokyo. Tokyo University; 1974: 118-125.

Turner, Terry L.; Myers, Charles C. Growth of Japanese larch in Vermont plantation. Vt. Agric. Exp. Sta. 672; 1972.

Utkin, A. I.; Atiskov, N. V.; Ermolova, L. S.; Vatkovsky, O. S.; Oskina, N. V. (Biological productivity of *Pinus sylvestris* L. and *Larix sibirica* Ledeb. in the Volga river region (Kuibyshev district)). Lesovedenie 2: 21-31; 1980.

Zavitkovski, J.; Dawson, David H. Intensively cultured plantations. Structure and biomass of 1- to 7-year-old tamarack in Wisconsin. TAPPI 61: 68-70; 1978.

Zavitkovski, J.; Lundgren, Allen L.; Strong, Terry F. Biomass production of 4- to 9-year-old *Larix eurolepis* grown in "Scotch plaid" plots in Wisconsin. Res. Pap. NC-231. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1982. 10 p.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1984—767-164/10064